


## Examples: 1<sup>st</sup> Law

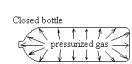


1. A car suddenly stops and you strain against the seat belt
2. When riding a horse, the horse suddenly stops and you fly over its head
3. A satellite travels in orbit constantly in a straight line



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## 1<sup>st</sup> Law of Motion

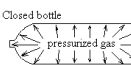
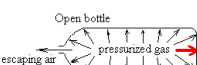
- Is a bottle rocket sitting on a launch pad: balanced or unbalanced?
  - **BALANCED!**

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## 1<sup>st</sup> Law of Motion


**BALANCED vs UNBALANCED**

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## 1<sup>st</sup> Law of Motion

- What makes a rocket unbalanced?
  - Thrust of the water releasing from the bottle makes it unbalanced

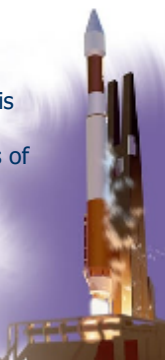


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## 2<sup>nd</sup> Law of Motion

- The acceleration of an object is directly related to the force & oppositely related to the mass of that object.


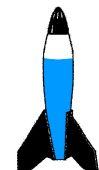
**$F = ma$**



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## Based on the 2<sup>nd</sup> Law...

- Will a lighter or heavier rocket travel further if they have the same force?

1/2 full of water      3/4 full of water

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## Based on the 2<sup>nd</sup> Law...

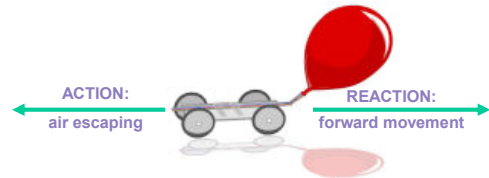
- Does the size of the bottle matter if we apply the same force of 100 psi?



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## 3<sup>rd</sup> Law of Motion

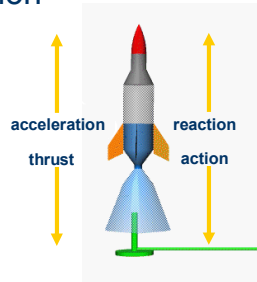
- For every action there is always an opposite & equal reaction.



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## 3<sup>rd</sup> Law of Motion

- The reaction of the rocket away from the launch pad is equal to & opposite from the thrust of the engine or nozzle



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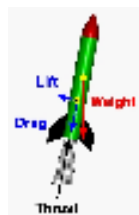
## Forces on a Rocket



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## Forces on a Rocket

- Lift
- Weight
- Drag
- Thrust



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## Lift


- Acts perpendicular to the direction of motion.
- The *lift* of a rocket is a side force used to stabilize and control the direction of flight.



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## Why fins?


- The shape, size, and quantity
- Why do rockets have fins?
  - An adaptation we make to rockets launched in our atmosphere is to give them fins. Fins work to help stabilize the rocket by moving the center of pressure below the center of balance. Without fins, the rocket would want to spin about its center of balance as it launches into the air. Moving the fins below the center of balance provides a restoring force as the surrounding air strikes the fins. You may notice that many modern rockets don't have fins. Many modern models have steerable propulsion units that are used to stabilize and direct the rocket's flight path of your fins.



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## Weight


- The force generated by the gravitational attraction on the rocket.



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## Drag


- Acts opposite the direction of motion and caused by friction and resistance of airflow



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## Thrust

- The force which moves the rocket through the air.
- Application of Newton's third law of motion.



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## Let's Review!


- Which Law?
- For a rocket to lift off from a launch pad, force must be exerted to unbalance the present forces at work
- 1st Law of Motion



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## Let's Review!

- Which Law?
- The rate at which the rocket leaves the launch pad will be determined by the mass of the rocket and the force that is produced when the fuel is burned.
- 2nd Law of Motion



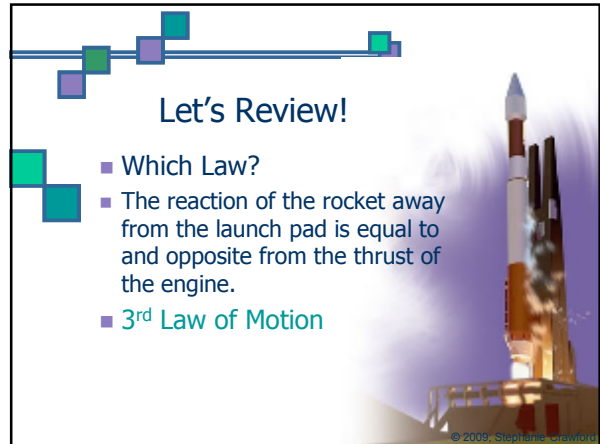
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## Let's Review!

- Which Law?
- Also known as the Law of Inertia
- 1<sup>st</sup> Law of Motion

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## Let's Review!

- Which Law?
- The reaction of the rocket away from the launch pad is equal to and opposite from the thrust of the engine.
- 3<sup>rd</sup> Law of Motion

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